



FAA-E-2387b

October 6, 1975

SUPERSEDING -

FAA-E-2387a, 12/11/69

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

INSTRUMENT LANDING SYSTEM MODULATOR

1. Scope and Classification

1.1 Scope.- The equipment specified herein is a solid state electronic modulator designed to modulate a CW RF carrier at 90 and 150 Hz sinusoidal rates to generate navigational signals for the localizer or glide slope portions of an Instrument Landing System (ILS). The modulator includes provisions for separating the modulated RF signal into a modulated carrier output and a sideband output (suppressed carrier) at the proper levels and phase relationships for distribution to a standard localizer or glide slope antenna system. Provisions are also included for varying the modulation level, amplitude and phase of the output signals to adjust and maintain the navigational system within prescribed performance standards and tolerances.

1.2 Classification.- Two types of modulators, classified by the performance characteristics required for use in the localizer or glide slope portion of the Instrument Landing System, are covered by this specification:

Type I Localizer

Type II Glide Slope

2. Applicable Documents

2.1 The following FAA specifications of the issues specified in the

invitation for bids or request for proposals, form a part of this specification:

FAA-E-163	Rack, Cabinet and Open Frame Types
FAA-G-2100/1	Electronic Equipment, General Requirements Part I, Basic Requirements for all Equipments
FAA-G-2100/3	Part III, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part IV, Requirements for Equipment Employing Printed Wiring Techniques
FAA-G-2100/5	Part V, Requirements for Equipment Employing Microelectronic Devices
FAA-D-2494/1	Instruction Book Manuscripts Technical Equipment and Systems Part I, Preparation of Manuscript
FAA-D-2494/2	Part II, Preparation of Manuscript Copy and Reproducible Artwork
FAA-STD-013	Quality Control Program Requirements
FAA-G-2300	Panel and Vertical Chassis, Rack

2.2 Military specification.- The following Military specification of the issue in effect on the date of invitation for bids or request for proposals, forms a part of this specification:

MIL-E-17555	Electronic and Electrical Equipment and associated Repair Parts, Preparation for Delivery of
MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms

(Copies of FAA specifications, drawings and standards, may be obtained from the Contracting Officer in the office issuing the invitation for bids or request for proposals. Requests should fully identify material desired; i.e., specification, amendment and drawing numbers and date. Requests should cite the invitation for bids, request for proposals, or the contract involved, or other use to be made of the requested material.) (Requests for military specifications should be forwarded to a Military supply depot as described in the Supplement to FAA-G-2100.)

3. Requirements

3.1 Equipment to be furnished by the Contractor.- Each equipment furnished

by the contractor, of the type specified in the contract schedule, shall be complete in accordance with all specification requirements and shall include the items tabulated below. Instruction books shall be prepared in accordance with FAA-D-2494 and furnished as specified in the contract schedule.

(a) Modulator (3.7.1)

(b) Power supply (3.7.2)

3.2 Definitions.- The definitions of MIL-STD-280 and FAA-G-1210 shall apply to the terms used in this specification.

3.2.1 Division terms, special categories.- The following special categories apply to the definitions of part, subassembly, assembly, unit, group, set and system, as well as the ancillary terms accessory and attachment of MIL-STD-280.

3.2.1.1 Replaceable assembly.- An assembly that is capable of being easily removed and replaced as an integral item. When applicable, any of the divisions listed in 3.2.1 may be used with the term replaceable.

3.2.1.2 Unitized construction.- A type of unit construction consisting predominately of replaceable assemblies.

3.2.1.3 Module.- A unit or standard of measurement, a fixed dimension.

3.2.1.4 Modular assembly.- A replaceable assembly having outline dimensions which are integral multiples of a module.

3.2.1.5 Modular construction.- A type of unitized construction consisting predominately of modular assemblies, with one or preferably two dimensions of each modular assembly fixed for any set or unit. Variation in size between individual assemblies shall be obtained by varying the other dimension(s) in integral multiples of the module.

3.2.2 Power Output.- The term "power output" is defined as the average power supplied at the Carrier Output. This shall include the navigational modulation components.

3.2.3 DDM.- The term "DDM" is defined as the difference in the depth of modulation of the 90 Hz and 150 Hz components applied to the carrier. Values of DDM are obtained by subtracting the smaller modulation percentage from the larger and dividing by 100.

3.2.4 Standard localizer signal.- A standard localizer signal is defined as an RF carrier amplitude modulated simultaneously with 90 Hz and 150 Hz signals so that the sum of the separate modulation percentages equals 40 percent and with the voltage waves of the 90 Hz and 150 Hz signals simultaneously passing through zero in the same direction each 1/30 of a second.

3.2.5 Standard glide slope signal.- A standard glide slope signal is defined as an RF carrier amplitude modulated simultaneously with 90 Hz and 150 Hz signal so that the sum of the separate modulation percentage equals 80 percent and with the voltage waves of the 90 Hz and 150 Hz signals simultaneously passing through zero in the same direction each 1/30 second.

3.2.6 Carrier modulation balance.- The term "carrier modulation balance" is defined by and will exist when the following conditions prevail at the Carrier Output:

- (a) Unity ratio between the 90 Hz upper and lower sideband signal levels.
- (b) Unity ratio between the 150 Hz upper and lower sideband signal levels.
- (c) Unity ratio between the total 90 Hz upper and lower sideband signals and the total 150 Hz upper and lower sideband signals.
- (d) Pure amplitude modulation only, with no frequency or phase modulation components.

The above conditions result in zero DDM at the Carrier Output.

3.2.7 Sideband balance.- The term "sideband balance" is defined by and will exist when the following conditions prevail at the Sideband Output:

- (a) Unity ratio between the 90 Hz upper and lower sideband signal levels.
- (b) Unity ratio between the 150 Hz upper and lower sideband signal levels.
- (c) Unity ratio between the total 90 Hz upper and lower sideband signals and the total 150 Hz upper and lower sideband signals.

3.2.8 Total modulation balance.- The term "total modulation balance" is defined by and will exist when the following conditions prevail:

- (a) Carrier modulation balance (3.2.6)
- (b) Sideband balance (3.2.7)

3.2.9 Sideband ratio.- The term "sideband ratio" is defined as the ratio of the total (90 Hz and 150 Hz) sideband power delivered at the Carrier Output to the total (90 Hz and 150 Hz) sideband power delivered at the Sideband Output.

3.2.10 Stray radiation.- The term "stray radiation" is defined as the emission or leakage of the fundamental frequency signals from the equipment at points other than from the normal equipment output(s).

3.2.11 Spurious emissions.- The term "spurious emission" is defined as emissions on a frequency or frequencies which are outside the band of frequencies necessary for transmission of information and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, hum, noise and intermodulation products, but exclude emissions that result directly from the modulation process and which are necessary for the transmission of information.

3.2.12 Optimum modulator adjustment.- The term "optimum modulator adjustment" is defined as the simultaneous achievement of the following conditions:

- (a) Power output (3.2.2) at the Carrier Output RF receptacle with input power to the modulator as follows:

	<u>Modulator Type</u>	<u>Input</u>	<u>Output</u>
(1)	I	120 watts	23.5 watts minimum
(2)	II	80 watts	14.9 watts minimum

- (b) Normal setting of the Sideband Amplitude Control (3.14.6.3)

- (c) Modulation percentages at the Carrier Output as follows:

	<u>Modulator Type</u>	<u>Modulation percentage</u>
(1)	I	20% of each at 90 Hz and 150 Hz
(2)	II	40% of each at 90 Hz and 150 Hz

3.3 General functional requirements.- The localizer is that component of the Instrument Landing System that provides guidance in the horizontal plane to aircraft engaging in approaches to airports. The glide slope is the component that provides the guidance in the vertical plane. The modulator specified herein modulates an RF carrier furnished by a separate transmitter (not furnished under this specification) with sinusoidally varying 90 Hz and 150 Hz tones to produce the standard localizer and glide slope navigational signals. The modulated RF signals are separated into modulated carrier signals and sideband only (suppressed carrier) signals which are distributed to a Carrier Output and a Sideband Output at discrete phase and amplitude relationships which are suitable for feeding the localizer and glide slope antenna systems (not furnished under this specification).

3.4 Ambient conditions.- The ambient conditions shall be those of Environment II (1.3.2.23, FAA-G-2100/1).

3.5 Power source.- The equipment shall operate from a single-phase two wire AC line power source at each of the following voltages, specified in terms of design - center values (1-3.2.21, FAA-G-2100/1):

240 V. and 120 V.. Voltage changeover provisions shall consist of solder links (not accessible on exterior of equipment). As shipped from the Contractor's plant, the equipment shall be connected for 240 V operation and fuses, where applicable, shall be provided for 240 V operation. It shall not be necessary to change indicator lamps or their circuits when changing to either AC line power source voltage. To provide the capability for the modulator to be used without the power supply on DC power furnished by rechargeable lead acid storage batteries, the power furnished by the power supply unit to the modulator unit shall have a design center voltage of 24V. The normal test condition tolerances shall be $\pm 2V$. and the service condition range shall be 20V. to 28V. (modifies 1-3.2.21 thru 1-3.2.23 of FAA-G-2100/1).

3.6 Frequency range.- The equipment shall operate over one of the following frequency ranges which correspond to the modulator type specified in the invitation for bids or request for proposals.

<u>Modulator Type</u>	<u>Frequency Range</u>
I	108-112 MHz
II	328-336 MHz

3.7 Mechanical design.- The equipment shall be constructed on panel/chassis units designed for mounting in a standard cabinet type rack manufactured in accordance with Specification FAA-E-163. (The rack shall not be furnished under this specification). The panel/chassis units shall be constructed for mounting by means of the panel mounting holes in the front of the rack which have been sized and located in accordance with FAA-E-163. Any other attachment to the rack for mechanical support of the chassis/panel unit is prohibited. The dimension of the units shall allow installation and mounting without any interference between the rack and the panel/chassis units or any part mounted thereon. The depth of the units shall not exceed 14 3/4 inches when measured between the rear surface of the front panel and the rear most surface of the chassis, including any projection or part mounted thereon.

3.7.1 Modulator unit.- The modulator unit shall be constructed on a front panel and chassis assembly with drawer slides and outer case which will allow the unit to be withdrawn from the front of the rack for maintenance. The case shall enclose the chassis on both sides and the bottom and provide mechanical support for the unit and a rigid mounting surface for the drawer slide assemblies. The top of the case and the upper half of the rear vertical surface shall be cut out to permit withdrawal of the unit from the rack without disconnecting any of the RF input or output cables. A barrier type terminal strip shall be provided on the left side of the rear vertical surface of the case for connecting input D.C. power. A flexible cord with retracting spring shall be provided between the barrier type terminal strip and the D.C. input of

the modulator to enable the modulator to be withdrawn from the rack without interrupting the input power. To improve ventilation, the case bottom surface shall be perforated with identical size, evenly space holes approximately one inch in diameter. Except as modified herein, the front panel and chassis assembly and case shall conform to the requirements of FAA-G-2300. The height of the front panel shall be 10 15/32 inches (size K panel per Drawing D-21140). The front panel shall be cut such that the modulator may be withdrawn from the rack without removing the rack trim strips of FAA-E-163. The drawer slides shall be provided with latching stops to limit the normal travel of the chassis to that sufficient for complete access to the modulator components and by intentional unlocking of the stops, to permit complete removal of the chassis from the rack. Strip-line, Slab-line, Tri-plate or rigid coaxial assemblies (solid metal sheath) shall be utilized as appropriate for the RF networks. The use of cable other than rigid coaxial cables for any of the RF networks, power dividers or hybrids is prohibited; however, flexible or rigid cable may be utilized for interconnections between the modules of the modulator. Dummy loads shall be provided to properly terminate the various RF networks and components within the modulator.

3.7.2 Power supply unit.- The power supply unit shall be constructed on a Type II Rack Panel and Verticle Chassis in accordance with FAA-G-2300. The height of the front panel shall be 6 31/32 inches (Size D panel per Drawing D-21140). A barrier type terminal strip shall be provided on the left side of the chassis for connecting DC power to the modulator.

3.8 AC input connector.- The AC input connector shall be mounted on the rear surface of the power supply chassis. The connector shall be Industry Number 7556-G, 3-wire polarized, grounded, twist-lock type receptacle for use with Industry Number 7555-G mating connector.

3.9 RF input and output connectors.- The RF input connector and two output connectors of the modulator shall be Type N chassis receptacles. Mating connectors shall be Type UG-1185/U with captivated center conductor for attachment to RG-214 cable. The remaining connectors within the modulator shall be Type N or Type TNC.

3.10 DC line controls to be provided.- In addition to the requirements of FAA-G-2100/lb, paragraph 1-3.6, the equipment shall include the following DC line controls mounted on the modulator unit front panel:

- (a) Front-panel mounted "main power" switch or circuit breaker, permitting manual control of the application and removal of DC line voltage to the equipment (FAA-G-2100/l, 1-3.6.1 to 1-3.6.3).
- (b) Front-panel mounted DC line indicator light (FAA-G-2100/l, 1-3.16.5.1 to 1-3.16.5.2.1).

3.11 Electrical overload protection.- The equipment shall include overload protection in the modulator unit for the 24V DC power input circuit in addition to the overload protection provided in the power supply unit in compliance with FAA-G-2100/1, 1-3.7.

3.12 Parts, materials and processes.- The equipment shall be designed and manufactured in accordance with the requirements of the following parts of FAA-G-2100, Electronic Equipment, General requirements.

FAA-G-2100/1 Part I, Basic Requirements for all Equipments

FAA-G-2100/3 Part III, Requirements for Equipment
Employing Semiconductor Devices

FAA-G-2100/4 Part IV, Requirements for Equipment
Employing Printed Wiring Techniques

FAA-G-2100/5 Part V, Requirements for Equipment
Employing Microelectronic Devices

All active circuit elements shall be solid state devices. The use of vacuum tubes is prohibited.

3.13 Maintainability.- The equipment shall be designed to enable rapid restoration to normal operation following failure by the replacement of defective modules from a stock of spare modules maintained at the equipment site. The defective module will then be repaired at the site and returned to stock.

3.13.1 Unitized modular construction.- Unitized modular construction, miniaturization and printed wiring shall be used to achieve the required maintainability. All modules shall be plug-in for ease of replacement and to permit rapid interchangeability with spare assemblies. Each module shall be marked and keyed such that it can be installed only in the correct receptacle and orientation for proper circuit connection. When a module requires fastening to secure it in its operating position, the fastening device(s) shall be either screwdriver slotted captive screws or screwdriver slotted one quarter turn quick release fasteners.

3.13.2 Test points.- Each module or assembly shall include one or more test points, through isolation networks where necessary, so located in the circuit that a single measurement at that point will indicate acceptable module performance or failure. The test points shall be located on that surface which is accessible when the assembly is mounted in the equipment. Parameters measured at these test points shall be limited to those which require the use of test equipment selected from the following list:

- (a) Volt-ohmmeter
- (b) Oscilloscope
- (c) Vacuum tube voltmeter

3.13.3 Module extenders.- Module extender cards or cables shall be provided to enable the equipment to be used as a test bed during trouble analysis and repair. Each extender shall include provisions for injecting test signals and connecting test equipment at appropriate points for use during performance of routine and corrective maintenance.

3.13.4 Test data.- Trouble shooting data shall be provided in the instruction book prepared in accordance with FAA-D-2494 to enable a technician using readily available common test equipment to isolate an equipment malfunction to the defective part(s) causing the malfunction. This data shall include the following:

- (a) Resistance measurements (under static conditions) between suitable reference point(s) and such other points that would be of assistance in identifying faulty items.
- (b) Voltage measurements, with power applied to the assembly.
- (c) Signal measurements specifying the particular input conditions.

3.14 Electrical Design.- The modulator unit shall be of unitized modular construction designed to consist of the following modules:

- (a) Input Conditioner/Sideband Balance
- (b) Combiner/Percent Modulator
- (c) Sideband Phase
- (d) 90 Hz Modulator
- (e) 150 Hz Modulator
- (f) Sideband Attenuator
- (g) Regulator/Signal Source
- (h) 90/150 Hz Diode Detector

Although there are several techniques available for achieving the desired performance, a modulator designed in accordance with Figure 1 will meet the performance requirements specified.

3.14.1 Power Handling.- The modulator unit shall operate continuously with an RF power input to the modulator of:

	<u>Modulator Type</u>	<u>RF Power</u>
a.	I	125 watts
b.	II	85 watts

without arcing and with no component part increasing in temperature more than 10°C above the ambient temperature of the air surrounding the component inside the equipment except RF terminations and semi-conductors which shall remain within the manufacturer's specified rating.

3.14.2 Efficiency.- The RF power loss in the modulator shall not exceed 80 percent of the RF input power over the range of service conditions.

3.14.3 Input impedance.- The input impedance to the modulator shall be 50 ohms and shall remain essentially constant throughout the modulation cycle with a maximum allowable input VSWR of 1.20. This requirement shall be met when the input power to the modulator is varied over the following range:

	<u>Modulator Type</u>	<u>Power Range</u>
a.	I	50 to 120 watts
b.	II	40 to 80 watts

3.14.3.1 Coaxial Cable VSWR.- Each length of rigid coaxial cable furnished (including connectors) shall have measured VSWR that does not exceed 1.10. Each length of flexible coaxial cable furnished (including connectors) shall have a measured VSWR that does not exceed 1.20. This requirement applies over the full operating frequency range.

3.14.4 Stray radiation.- With the modulator adjusted for optimum conditions and with the Sideband Amplitude control in its midrange position, the stray radiation shall not exceed 20 microwatts (ERP).

3.14.5 Spurious emissions.- Spurious emissions shall be at least 60 dB below the carrier level measured at the Carrier Output receptacle.

3.14.6 Front panel controls and adjustments.- The following controls and adjustments shall be mounted on the modulator front panel and shall be accessible without withdrawing the modulator from the rack. Each control specified shall have a locking device to prevent the inadvertent movement of the control.

3.14.6.1 Modulation Percent.- A continuously variable control marked Modulation Percent shall be provided for adjusting the modulation levels of the signals at the Carrier Output receptacle over the following range:

	<u>Modulator Type</u>	<u>Modulation Percentage</u>
a.	I	17 to 23 percent
b.	II	38 to 42 percent

Variation of the control from its mid-range position to the limits of the above specified range shall not produce RF phase changes greater than ± 3 degrees between the carrier and sideband outputs. Variation of input power to the modulator over the range of input powers specified shall not cause more than 1.25 percent change in the modulation percentages of the Carrier Output signals for all settings throughout the range of adjustment of the Modulation Percentages control. Not less than 50 degrees of mechanical rotation shall be utilized in covering the minimum modulation range specified above.

3.14.6.2 Modulation Balance.- A continuously variable control marked Modulation Balance shall be provided for precisely adjusting the total modulation balance and for simulating changes in the localizer/glide slope course position. Throughout the range of adjustment of the modulation percentage control and without making any other adjustments within the modulator, adjustment of the modulation balance control shall provide total modulation balance, defined as mid-range. After establishment of modulation balance as defined, the balance control shall have sufficient additional range to permit unbalancing the 90 and 150 Hz sideband signals in both directions (90 Hz or 150 Hz higher) by not less than 1.5dB for simulating changes in the localizer/glide slope course position. Variation of the balance control from midrange position to the limits of the above specified range shall not produce changes greater than ± 3 degrees in RF phase from that existing at mid-range position between the sideband signal at the carrier and sideband outputs and shall not change the total depth of modulation of the carrier output signals by more than 1 percent modulation. After establishment of modulation balance, variation of input power to the modulator over the range of power specified in 3.14.3 shall produce not more than 0.1dB change in the total modulation balance.

3.14.6.3 Sideband Amplitude.- A control marked Sideband Amplitude, with not more than one fixed attenuator as required, shall be provided for continuous adjustment of the sideband output over the range specified below. The control shall provide for the adjustment of the signals at the Sideband Output over a range of at least ± 6 dB from its normal setting. Normal setting for the control shall be such that signals appearing at the Sideband Output shall be 3.0 ± 0.3 dB below the value of the sideband signals appearing at the Carrier Output. Variation of the control from mid-range position to the limits of the above specified range shall not produce greater changes than ± 5 degrees in RF phase between the sideband signals appearing at the carrier output and those at the sideband output. For any setting of the Sideband Amplitude control, variation of input power to the modulator over the range of power specified in 3.14.3 shall cause not more than 0.2 dB change in the sideband ratio. Variation of the control over its specified range from normal setting shall cause not more than ± 0.2 dB change in the total modulation balance and ± 1.25 percent change in the modulation percentages at the Carrier Output. Not less than 160 degrees of mechanical rotation shall be utilized in covering the minimum adjustment range specified above.

3.14.6.4 Sideband Phase.- A continuously variable phasing control marked Sideband Phase shall be provided for shifting the RF phase of the signals appearing at the Sideband Output over a range of at least ± 30 degrees from normal. Normal setting for this control with the other controls set for optimum modulator adjustment shall be such that the RF phase of the 150 Hz sidebands at the Sideband Output are in phase with the 150 Hz Sidebands at the Carrier Output and the 90 Hz sidebands at the Sideband Output are 180 degrees out of phase with the 90 Hz sidebands at the Carrier Output. The control shall be calibrated in increments of 2.0 electrical degrees. Variation of the control over its specified range from normal setting shall cause not more than ± 0.1 dB change in the total modulation balance and ± 0.2 dB change in the sideband ratio. The control shall require not less than 2.5 degrees of mechanical rotation or 1/10 inch linear displacement per electrical degree of phase shift.

3.14.7 Carrier/Sideband Phase.- A continuously variable control marked Carrier/Sideband Phaser shall be provided for varying the RF phase of the sideband signal being used to modulate the carrier signal. The control shall not be mounted on the front panel. The control shall provide for adjustment of the sideband/carrier RF phase to effect maximum modulation of the carrier by the sideband signal when the modulation is observed at the Carrier Output receptacle. The range of adjustment shall provide for optimum phasing over the operating frequency range. Variation of the control over its range of adjustment shall cause not more than ± 0.1 dB change in the total modulation balance.

3.14.8 Relationship between navigation tones.- The signals appearing at the Carrier Output shall be such as to produce demodulated 90 and 150 Hz voltage patterns which pass through zero within 50 microseconds of each other in the same direction, every 1/30 second.

3.14.9 Distortion of navigation signals.- With the modulator adjusted for optimum conditions, the signals appearing at the Carrier Output and Sideband Output receptacle shall be such as to produce a demodulated signal with equal 90 and 150 Hz components and distortion components which do not exceed the following:

<u>Frequency</u>	<u>Distortion component referred to 90 or 150 Hz signal</u>
180 Hz	3 percent
270 Hz	4 percent
300 Hz	4 percent
450 Hz	4 percent
All other frequencies within the range of 30 to 4000 Hz	2 percent

In addition, the total harmonic distortion shall not exceed 10 percent. These distortion requirements shall be met with the input power to the modulator varied over the range specified in 3.14.3. Suitable provisions such as carrier reinsertion or other appropriate techniques shall be used for measuring the distortion of the sideband signals.

3.14.10 Sideband output, 90/150 Hz unbalance.- For all settings of the sideband amplitude control within the range specified in 3.14.6.3 and with carrier modulation balance adjusted for unity ratio at the Carrier Output, the unbalance between the 90 Hz and 150 Hz sideband signals at the Sideband Output shall not exceed 1.0 dB.

3.14.11 Test Circuits.- For test purposes, four identical linear detectors for sampling the respective signals at the Carrier Output, Sideband Output, 90 Hz Output and 150 Hz Output, shall be provided. With the modulator adjusted for optimum conditions, each detector output shall be capable of providing a test signal of not less than 300 millivolts across a 20,000 ohm load. The total distortion from each detector shall not exceed 2 percent and the frequency response shall not vary more than 2 dB from 30 to 4000 Hz. The demodulated output from the detectors shall be brought to Type BNC RF coaxial connectors mounted on the front panel of the modulator. These connectors shall be marked Carrier Test, Sideband Test, 90 Hz Test and 150 Hz Test, respectively. The test circuits shall be sufficiently shielded so as to completely eliminate the effects of hand capacity, body movement, etc., on the individual patterns when viewed on an oscilloscope or wave analyzer.

3.14.11.1 Tone test switch.- A tone test switch shall be provided for each navigational tone to enable either tone to be turned on or off independently of the other for the purpose of making modulation percentage and distortion measurements. The test switches shall be mounted behind the front panel in a position such that they are readily assessable when the chassis is withdrawn from the rack. Operation of either switch shall not cause any change in the carrier level or the level of the tone that is not being switched.

3.14.12 Carrier Suppression.- With the modulator adjusted for optimum conditions for any combination of Sideband Amplitude control or Sideband Phaser control settings, the carrier power appearing at the Sideband Output shall be 30 dB or more below the carrier power appearing at the Carrier Output.

3.14.13 Stability.- When adjusted under normal test conditions for optimum modulator adjustments, changes in the following parameters over the range of service conditions shall not exceed the following:

- (a) Carrier power Output (with input power maintained constant) 10 percent overall
- (b) Sideband ratio ± 0.5 dB

- | | | |
|-----|---|---|
| (c) | Carrier modulation | Type I 19.0 to 21.0 percent
(each tone) |
| | | Type II 38.0 to 42.0 percent
(each tone) |
| (d) | Carrier modulation
balance | ± 0.2 dB (3.2.6)(c) |
| (e) | Sideband balance | ± 0.3 dB (3.2.7)(c) |
| (f) | RF phase between
Carrier and Sideband
Outputs | ± 10 degrees |
| (g) | Simulated course width | ± 8 percent |
| (h) | Modulation frequencies | ± 1 percent |

for (g), the signal at the Carrier Output and the Sideband Output shall be combined in a suitable test fixture. The above requirements shall be met at all settings of the Sideband Amplitudes Control within the range specified in 3.14.6.3.

3.14.14 Stabilization time.- After initial adjustment for optimum conditions (3.2.12) under normal test conditions, changes from the initial room temperature readings occurring between 5 seconds and 15 minutes after initial application of power under each of Steps 3, 6 and 8 of 1-4.12 of FAA-G-2100/1 (modifies 1-4.12 for this application) shall not exceed the limits tabulated below. The reading for each parameter shall be taken starting three seconds after energizing the equipment and on a continuous recording basis for the first 15 minutes after energizing:

- | | |
|---|---|
| (a) Carrier power Output
(with input power
maintained constant) | ± 5 percent |
| (b) Sideband ratio | ± 0.5 dB |
| (c) Carrier modulation | Type I 18.5 to 21.5 percent (each tone)
Type II 38.0 to 42.0 percent (each tone) |
| (d) Carrier modulation
balance | ± 0.3 dB (3.2.6)(c) |
| (e) Sideband balance | ± 0.3 dB(3.2.7)(c) |
| (f) RF phase between
Carrier and Sideband
Outputs | ± 10 degrees |
| (g) Simulated course width | ± 10 degrees |
| (h) Modulation Frequency | ± 1 percent |

For (g), the signals at the Carrier Output and the Sideband Output shall be combined in a suitable test fixture. The above requirements shall be met at all positions of the sideband amplitude control within the range specified in 3.14.6.3.

3.15 Nameplate.- A nameplate shall be provided on the front panel of the modulator in accordance with paragraph 1-3.13 of FAA-G-2100/1. The equipment title shall be in accordance with the modulator type specified in the contract schedule as follows:

<u>Type</u>	<u>Title</u>
I	ILS Modulator - Localizer
II	ILS Modulator - Glide Slope

4. Quality Assurance Provisions

4.1 General.- The contractor shall be responsible for conducting all inspection and testing to assure product conformance with the requirements of this specification and shall utilize for this purpose a quality control program in accordance with Section 1-4 of FAA-G-2100/1. All tests under paragraphs 4.2 thru 4.5 shall be performed with input power to the modulator as follows:

<u>Modulator Type</u>	<u>Power</u>
I	120 watts
II	80 watts

except where specifically indicated otherwise in the listed paragraphs.

4.2 Design qualification tests.- In addition to the tests specified in 1-4.3.2, FAA-G-2100/1, the tests listed in the following tabulation shall be conducted:

(a) Under normal test conditions.-

<u>Paragraph</u>	<u>Test</u>
3.6	Frequency range (Type I 108 MHz, 112 MHz) (Type II 328 MHz, 336 MHz)
3.14.6.1	Modulation percentage adjustment (phase shift, input power variation, mechanical rotation)
3.14.6.2	Modulation balance adjustment (phase shift, total modulation change, input power)
3.14.6.3	Sideband amplitude control (phase shift, input power variation, mechanical rotation)
3.14.6.4	Sideband phase (mechanical rotation)

- 3.14.7 Carrier/Sideband Phase (optimum Modulation)
- 3.14.11 Test circuits (signal level, frequency response, shielding)
- 3.14.4 Stray radiation
- 3.14.5 Spurious Emission
- 3.5 DC operation (on power furnished to modulator unit by lead-acid storage batteries)

(b) Under service conditions. (These tests shall be conducted in accordance with the environmental test procedures described under 1-4.12 of FAA-G-2100/1)

- 3.14.1 Modulator power handling capability (+50°C, with power specified applied for minimum of 3 hours)
- 3.14.13 Stability (+3 dB and -9 dB amplitude control settings)
- 3.14.14 Stabilization time (+3 dB and -9 dB sideband amplitude control settings; steps 3 and 6 of 1-4.12 of FAA-G-2100/1)
- 3.14.8 Relationship between navigation tones

4.3 Type tests under the service conditions.- The tests listed in the following tabulation shall be conducted in accordance with the environmental test procedures described under 1-4.12 of FAA-G-2100/1:

- 3.14.9 Distortion of navig. signals
- 3.14.3 Input impedance
- 3.14.12 Carrier Suppression
- 3.14.2 Efficiency
- 3.14.13 Stability (normal setting of sideband amplitude control)

4.4 Type tests under normal tests conditions.- The tests listed in the following tabulation shall be conducted under normal test conditions:

- 3.14.13 Modulation frequency stability (57 Hz, 63 Hz)
- 3.14.14 Stabilization time (normal setting of sideband amplitude control; step 8 of 1-4.12 of FAA-G-2100/1)
- 3.14.9 Distortion of navig. signals (108 MHz, 112 MHz)

4.5 Production tests.- The tests listed in the following tabulation shall be conducted on each equipment under normal test conditions:

3.14.6.1	Modulation percentage adjustment (range of adj.)
3.14.6.2	Modulation balance adjustment (range of adj.)
3.14.6.3	Sideband amplitude control (normal setting, range of adj., effect of control variation)
3.14.6.4	Sideband phase control (normal setting, range of adj., effect of control variation)
3.14.8	Relationship between navig. tones
3.14.9	Distortion of navig. signals
3.14.3	Input impedance
3.14.11	Modulator tests circuits (distortion)
3.14.2	Efficiency
3.14.10	Sideband unbalance
3.14.3.1	Coaxial cable VSWR
3.14.12	Carrier suppression

4.6 FCC type acceptance procedures.- The first production equipment shall be subjected to the FCC type acceptance procedures specified in 1-4.3.5 of FAA-G-2100/1.

5. Preparation for Delivery

5.1 General.- Unless otherwise specified in the contract, the equipment shall be prepared for domestic shipment in accordance with the following subparagraphs. Two copies of the approved equipment instruction book shall be packed and shipped with each equipment.

5.2 Preservation and packaging.- Preservation and packaging shall be in accordance with Specification MIL-E-17555, Level A, Method II.

5.3 Packing.- Packing shall be in accordance with Specification MIL-E-17555, Level B. No more than one set of equipment and associated items shall be packed in each shipping container.

5.4 Marking.- Each package and shipping container shall be durably and legibly marked with the following information:

Name of Item and FA Type Designation

Serial Number(s)

Quantity

Contract Number

National Stock Number

Gross Weight of Container

Manufacturer's Name

6. Notes

6.1 Note on information items.- The contents of this Section 6 are only for the information of the initiator of the procurement request and are not a part of the requirements of this specification. They are not contract requirements nor binding on either the Government or the contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the contractor on the information in these subparagraphs is wholly at the contractor's own risk.

6.2 Ordering data.- Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type (see 1.2) and quantity of each modulator on order.

* * * * *

APPENDIX

1. Status of Index.- The presence, absence, juxtaposition, or referencing of any item or paragraph number in the following alphabetical index has no significance with respect to the requirements of this specification. The index is appended merely as a matter of convenience; no assurance is offered that paragraph references are complete and the omission of a reference to any specification requirement has no effect upon the requirement.

2. Arrangement of Index.- The alphabetical index which follows is arranged according to paragraph content, not necessarily by paragraph headings.

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Ambient conditions	3.4
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Modular	3.2.1.4
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Balance	
Carrier modulation	3.2.6
Modulation	3.14.6.2
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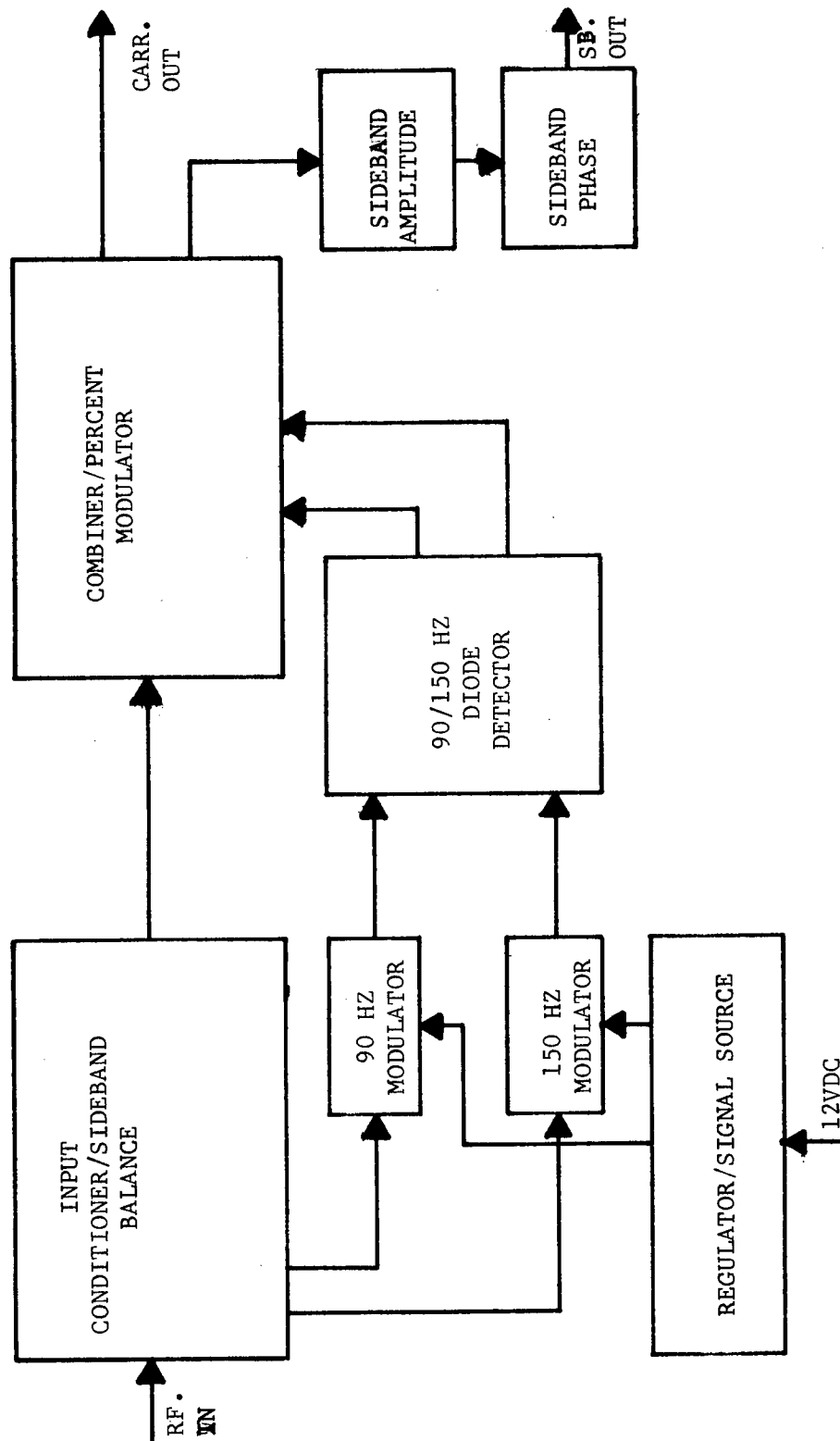


FIGURE 1. ILS MODULATOR BLOCK DIAGRAM

